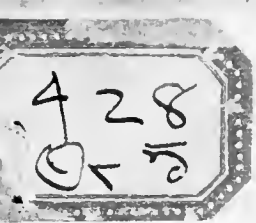


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WARBLES IN HIDES:

Their Cause and Prevention & Cure.

BY

WILLIAM S. HORN.

COMPILED CHIEFLY FROM REPORTS AND OBSERVATIONS BY
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ESSAY ON WARBLES IN HIDES:

Their Cause and Prevention or Cure.

THE Warble Fly, or Ox Bot Fly (*Hypoderma Bovis*, De Geer; *Æstrus Bovis*, Clark), is an insect belonging to the order Diptera, and is classed in the sub-division *Æstridæ*. There are several different insects belonging to this class, and it is peculiar that each species is confined to its own quadruped: for instance, the Horse Bot Fly attacks the horse, the Ox Bot Fly attacks cattle, and that of the sheep, reindeer, &c., attacks those animals respectively. They have also each their own mode of attack, the Horse Bot Fly laying its eggs on the hairs of the leg or mane, the Ox Bot Fly its eggs in or on the hide, while those of the Sheep Bot Fly are laid in the nostril of the animal. Their maggots reside respectively in the stomach, hide, and nostril of the animals before mentioned, and from these circumstances the *Æstridæ* are divided into three main sections—viz., the Gastric, of which the Horse Bot Fly is an example; the Cutaneous, as the Ox Bot Fly; and the Cervical, as the Sheep Nostril Fly. The Ox Bot Fly, or Warble Fly, is slightly more than half an inch long, and is rather larger than the common Horse Bot Fly. It is not unlike a light-made Humble Bee in appearance, indeed an inexperienced observer might easily mistake it for one, at first sight. Its body is covered with hairs; the head is large, the



Fig. 1.—Warble Fly or Ox Bot Fly.

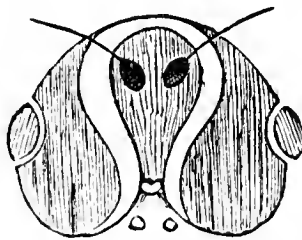


Fig. 2.—Head magnified.
(After George Shaw, M.D., F.R.S., &c.)



face being of a yellow colour. Very few of the perfect insects have a mouth, and they do not feed during the fly state. There are four raised lines along its fore body or

thorax, resembling dusty streaks. The abdomen is white or yellowish at the base, black in the middle, and orange at the end. The legs are black, with red feet; the wings of a brownish colour, and unspotted, and with two large alulets. The body between the wings is yellowish before and black behind. The female is furnished with a long egg-laying tube, or ovipositor, which is described by Reaumur as consisting of four tubes, one within the other, and the insect is capable of pushing them out like a pocket telescope. The outer tube is hard and shelly, and the inner one is terminated by five sharp points, of which three are hooked, and longer than the others. The fly is without any sucker; the antennæ are very short, proboscis and palpi obsolete, thorax smooth, and the body in the female very long. It is found from Norway and Sweden to the South of Europe, also in Asia, Africa, South America, &c., in fact in almost all parts of the world.

In Norfolk and Suffolk these flies are reckoned useful by the ignorant, and as the *Æstrus* selects the healthiest cattle, the farmers prefer those cows which have on their backs three or four lumps or "bots" produced by this insect. The fly seldom appears until June.

The cattle have a great dread of this fly. At the first sound of its buzz they at once gallop off in extreme terror, with tails stretched out and necks extended, endeavouring to get out of reach of their winged assailant. From the appearance of temporary madness in oxen when pursued by this insect, the Greeks applied the term "*æstrus*" to any sudden fit of fury, or sudden impulse in man.

In places where ploughing with oxen is practised, the attack of this insect may be dangerous, as they at once become perfectly unmanageable, and, whether in harness or yoked to the plough, will run directly forward.

The female fly is observed to be very expeditious in oviposition—not more than a few seconds. She fastens on the back of an ox or cow, leaving only one egg in a place, with an interval of one or two inches between each insertion. While she is performing the operation the animal attempts to lash her off, as it does other flies, with its tail.

Bracy Clark, a great authority on Bot Flies, and other writers, state that when cattle are attacked by the Warble

Fly they gallop with the tail straight out, and that when the tail is carried upright the Gad Fly is the aggressor. After galloping with tail aloft, an ox was caught, and a fly, presumably a Gad Fly, was found attached to the brisket of the animal. The Warble Fly is sometimes erroneously called the Gad Fly; but the real Gad Fly has nothing to do with warbles. The Warble Fly is blamed for a great amount of the galloping, &c., of cattle, when the Gad Fly is the real offender. The sole object of the Warble Fly in attacking cattle is to lay its eggs; whereas the Gad Fly attacks them to suck blood, for which purpose it thrusts sharp lancets into the skin. It is also sometimes called the Breeze Fly.

Cattle of the age of one or two years are most subject to attack. Badly fed and kept animals are more often attacked than those which are well fed and cared for. The infliction takes greater effect on a young growing animal than upon one which is older and fuller in condition. Bulls are very subject to them; very likely because they are often fastened and have no means of freeing themselves from the fly in summer, and in winter are neglected and have no attention paid to the state of their backs. The Shorthorn seems more liable to attack than other classes of cattle, no doubt because of its thin hide, the Welsh and Scotch breeds having hides almost twice as thick.

Mr. D. Turvill, Hants, took half a number of bullocks which had grazed together, and fed them in stalls for fattening, while the other half were left out in an open yard as stores. In January and February not a single warble could be found in the stalled animals, while not one of the stores was free of them.

The back, sides, and loins, and top of shoulder blade, are the places most subject to attack. Mr. J. Dalton, Wigton, has many times in spring noticed hides taken from two-year-old bullocks where the back has been one mass of sores, caused by the Warble Maggot, the discoloured blood and matter showing how intense has been the inflammation. The insect probably chooses those parts of the animal for depositing its eggs because there it is the least likely to be disturbed by the animal switching its tail, or by licking or rubbing the place. Probably its instinct also prompts it to oviposit there. The

maggot will get additional warmth from the heat of the sun, and is not subject to any chill, which might retard its growth, by the animal lying down on the damp, cold ground.

Mr. Haines, Newport, has noticed that nearly all hides from yearling cattle that have died a natural death are covered with warbles.

In some yearling heifers we had last spring the fly seems to have been very impartial, as there were as many warbles on the poorer heifers as on those in good condition, and in some cases more ; but perhaps the poorness was the effect of the warbles.

Back-end calvers, that have had a summer's run out at grass, are a favourite object of attack of the Warble Fly. Where the maggots have fallen from the backs of cattle in a field, it is quite a matter of course that the flies will soon appear to start new attacks there.

Exposure without possibility of shelter, weakness, and neglect are all favourable to increase of warble attack, whether in old cattle or young. Under groves of trees some cattle were found to be quite free from attack. Where young cattle had sheds to run in at will during the day, and were housed at night, with a good feed of cake, there were seldom any warbles found. In places where there are large ponds, and the animals stand in the water during the hottest part of the day, the flies are not so rife, and the cattle are undisturbed by them.

Many writers have asserted that it will not cross any extent of water. Prof. W. Fream, Downton, said that their cattle did not suffer much ; but there was plenty of marshy ground near at hand, and a good deal of timber, which afforded shade. Some cattle we had in a field, in which were a number of trees and a pond, were very little troubled by the Warble Fly, while some cattle in an open field close too, were very much tormented by them.

Tanners have found that hides show less attack where the cattle have had access to water. Reaumur observes that Warble Flies attack cattle principally in woodland districts, not in the plains.

If cattle are removed from the pasture where they remained in the spring during the time the maggots escaped

to another place, it has been found that they are much less liable to attack, as the Warble Fly never goes far from its birth-place, as it might be called. Mr. J. Milne, Aberdeenshire, states that no Ox Bot Fly has been on his farm for ten years. His cattle are never seen galloping with tails erect. The fly never seems to come from other farms. Purchased animals generally had warbles in their hides, but good care was taken to get them out by making a small incision with a penknife, and pressing them out.

Where there are few or many Warble Maggots escaped, there is a corresponding difference in the amount of attack in summer. We had very few warbles on our own cattle this spring, as I pressed most of the maggots out the preceding year, showing a marked decrease where the Warble Maggots have been destroyed; but yearling bullocks and heifers we have had from Cumberland, Westmoreland, and Yorkshire, have had numbers on them.

Mr. Stratton observed that the cattle which he had cleared in spring were left in peace, while those not cleared, and in different pastures, were fly-tormented.

The duration of the attack is from one summer to another. Mr. J. Milne says the period when the Warble Flies annoy the ox, and deposit the eggs in that climate (Aberdeenshire) is from the middle of July to the middle of August. Cattle in low-lying districts are attacked sooner than those in hills. In the former, it may begin as soon as May or June, or, if the weather be cold and unfavourable, it will be a little later. It all depends on circumstances.

Cattle seem to possess an instinctive dread of the presence of this insect. On June 24th, I saw some heifers galloping about a field here with tails stretched out horizontally, and necks extended, but whether they were flying from the Gad Fly or Warble Fly I could not ascertain. On July 1st, some bullocks were running wildly with tails horizontal, others had their tails erect, some sideways, and a few had their tails curled right over their backs. On August 8th, the cattle were suffering very much from fly attack.

No doubt the laying of the egg extends over several weeks. There has been much scientific discussion as to whether the egg is laid on the cattle or inserted in the skin.

Reaumur, Kirby, and Spence, and other writers, were of opinion that the ovipositor was used to bore a hole through the hide, by means of the sharp points at the end of the inner tube, and sliding the eggs through the tube into the wound ; but recent researches by Miss Ormerod, Consulting Entomologist to the Royal Agricultural Society ; H. Thompson, V.S., Aspatria ; and others, have proved this opinion to be erroneous. Miss Ormerod is of opinion that the egg is fixed just below the cuticle, and that the maggot, after hatching there, burrows its way through the hide to the sub-cutaneous tissues. Sometimes this channel through the hide was of such a shape that it could not have been caused by the ovipositor of the insect ; as the channel by which the young maggot reaches the sub-cutaneous tissues is left open. This is an important point in the question of destroying it in its early stages, before it does any serious amount of mischief, because poisonous washings and dressings may thereby reach it, and choke up its breathing passages.

In the case of the nearly-allied Warble Fly of the reindeer, the female fly has been seen by Linnæus with the egg at end of ovipositor in the act of placing it on the hide ; and from this, it is highly probable that the Ox Warble Fly does the same.

Mr. Henry Thompson is also of opinion that the egg is placed in the cuticle or outer skin by the ovipositor.

Miss Ormerod states that the egg is somewhat spindle-shaped, with a small additional process at one end, so :—

If it could be seen which way the egg is placed in the ovipositor of a female about to lay, it would help to determine the point. It is probable that the fly sticks the egg fast in the hide

by this appendage, as in fig. 4. Miss Ormerod found a body stuck up as above, but being called away, she did not see it

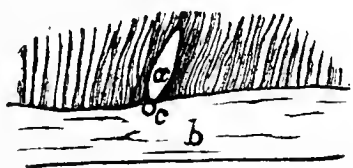


Fig. 4.—Egg *a* fastened in hide *b*, by the appendage *c*.

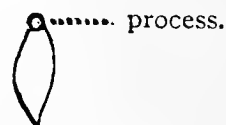


Fig. 3.—Egg of Warble Fly.

again until three hours afterwards, when she found it shrivelled up. It was pinkish, with a vein. She fancied it was a maggot which had thrown off the egg-pillule, and was just starting on its way through the hide (November 17th).

In the Death Watch Beetle the egg is securely glued to the wood, and the larva goes right into the wood from it, and has the egg-skin to support it and prise against in its first work. Perhaps the appendage may serve the same purpose of steadying the egg. The ovipositor, also, does not seem to be intended for inserting the egg in the skin. The joints are retractile within each other, and are saw toothed, as in fig. 5.



Fig. 5.—Ovipositor of Warble Fly.

The egg is of an oval shape and white, with a small brownish lump-like appendage at one end.

In applying mixtures to prevent attack, the following points should be acted on:—1st, Applying mixtures of such a strong smell as may be obnoxious to the fly, and overpower the attraction of the smell of the animal; 2nd, Applications which would stick the fly fast, or kill the egg; 3rd, Washes which would clear off the eggs, or destroy them if laid on the skin, or if lying just beneath the outer cuticle; and 4th, Protection afforded to cattle by being housed at egg-laying time.

As the Warble Fly is chiefly on the wing at noon on sunny days, it is desirable that cattle should have the means of sheltering amongst trees or bushes, where there would be some degree of shade, coolness, and moisture, which the fly dislikes. It would also be well worth while, in the case of valuable milch cows and young animals, to provide them with access to sheds. Where animals cannot get from the fly, it is natural that they will suffer more than others which can. All writers agree that the Ox Warble Fly does not go over water; therefore a shallow pool, where the cattle can stand during the hottest part of the day, is a great safeguard from attack. These and the following precautions are not only needed for protection against egg-laying, but to save the cattle from the persistent trot and headlong gallop which is often brought to an end in the afore-mentioned places. Soft soap and black sulphur mixed in grease; alum dissolved in water; quassia in water; guano as a wash, or mixed with clay and water, have all been well recommended for preventing egg-laying and killing the hatching maggot. Anything that will make the coat unfit for laying on, without injury to the animal, will

serve the purpose ; and the stronger and more repulsive the smell the better. But these are of no good if not used, and very often nothing is done until after egg-laying has begun.

The following mixture is recommended by Mr. Henry Thompson, as useful to prevent egg-laying :—4 oz. flowers of sulphur, 1 gill spirits of tar, 1 quart train (whale) oil ; to be mixed well together, and applied once a week to each side of the spine of the animal with a brush. By continuing this treatment during summer and autumn, the hide is made unattractive to the fly, preventing them depositing their eggs, and the animals are left in peace. It likewise destroys the egg or chokes the maggot by a broadside application, which includes all that is going on, whether seen or not. He says, paraffin, kerosine, carbolic acid, phenyle &c., are useful, but are too transient to be of service, and would have to be applied too frequently. He says it is a common practice to wash the cows' backs with strong pickling brine, applied two or three times in the season. This is a good remedy, as the ovæ would be destroyed immediately it was placed in the skin. He also found Stockholm or green tar very useful. It was applied between top of shoulder blade and loins, and on the back, on first turning the cows out. One application of this lasts the whole season. Sulphur mixed with train oil will keep off the flies ; or sulphur with linseed oil. Mr. Duckham, Ross, says he had each cow dusted along the back with sulphur ; and only two cows had one warble each, while their calves had several on their backs.

Mr. Hatton mentions a mixture of sulphur and carbolic acid ; but Mr. Duckham was of opinion this would burn the hair off where applied. Mr. B. St. John Ackers says that if cattle turned out in the fields (cattle in sheds escape entirely with him) are rubbed down the spine and loins and ribs with train oil, they are quite free from attack. He found two or three dressings enough ; but much depends on the season and thickness of coat. Mr. D. Lym Scott, Tipperary, applied spirits of tar, carbolic acid, sulphur, and linseed oil mixed together, once, to the backs of 28 two-year-old heifers showing symptoms of ringworm. The result was that not a single warble was found on them next year, although there were plenty on the others not treated, with which they had been.

A neighbour of ours at Stoke Ferry, about three miles distant, where the cattle are much afflicted with this pest, rubbed spirits of tar along the animals' backs about every other morning during summer, and he says they were quite free from warbles next spring.

About November 1st, 1884, Messrs. Hatton stated that they had recently found lumps about the size of buckshot on fleshy side of hide from a yearling. On November 12th, they forwarded a piece of hide to Miss Ormerod. It measured 12 by 4 inches, and on the flesh side were more than seven slight swellings about $\frac{1}{4}$ inch across, of a livid or bluish colour, each forming a raised centre to greatly inflamed patches. These were under the sub-cutaneous tissues. Within the blue centre Miss Ormerod found a small Warble Maggot, just large enough to be distinguished by the naked eye when removed, but not plainly so while in the swelling, as the inside of this was of blood-red tissue, and the maggot was of the same colour. It was plainly distinguished under the microscope by its patches of minute prickles. From the red mass or inflamed swelling a fine channel was found passing through the hide to the surface. While handling the specimen, blood was forced up from the swelling through the channel, and collected in a little drop on the outside. Within these swellings the maggot lay free—that is, not enclosed in a cell. The channel appeared to have no lining membrane, but to be merely a passage gnawed or torn by the mouth hooks of the maggot, and was sometimes slanting, or taking a straight course, or so completely curved at the upper part of its course that it was not possible for the ovipositor to have caused it where the curve existed, proving that the egg is laid either outside or just beneath the outer cuticle of hide. In one instance, she found the gallery or maggot-run curved back, and running just under the cuticle, and ending in a cell (A), as in fig. 6. She also found some similar small cells without any gallery down, and in some of these she found a gallery just beginning to be formed in one case, and in another, an object not as yet in a prickly skin, but full of blood, and which she concluded to be the early

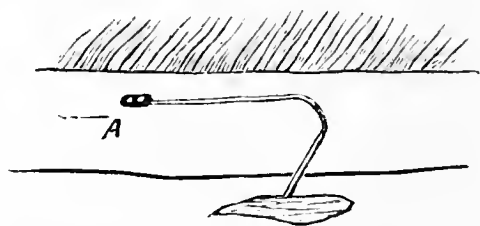


Fig. 6.—Curved maggot run.

stage of the maggot, half-way down the white thick portion of the hide. She thinks the first stage of the maggot, until it gains its prickly coat, is passed harmlessly in the sub-cutaneous tissues. Dr. Brauer says the beginning of the cell takes place in the sub-cutaneous tissues, to which the minute grub has burrowed down, as some think by the hair follicle, but this latter point is doubtful. In the United States and on the Continent the warble becomes visible on fleshy side of hide in the latter part of September. On December 5th, two swellings were found on the fleshy side of hide of a bullock killed the previous day at Spring Grove, Isleworth.

The first note of outside swelling was reported by Mr. David Byrd, Tarporley, Cheshire, on December 4th, 1884. He says:—"We see many lumps on the backs of cattle, at present not large." In beasts fed at Aberdeen under cover, two embryo warbles were found on December 26th, 1884. I have examined the backs of several two-year-old bullocks and heifers, afflicted with warbles in the spring, during this month (December), up to the 21st December, but have been unable to find any warble swellings.

From German observations, about the end of August or beginning of September is about the time the warble opens on the Continent. One observer considers the warble begins to form very soon after the presence of the maggot in the hide, and three or four weeks after he has noticed the animal trying to get at the spot with its tongue, he has found a little lump, and squeezed out the maggot when only the size of a Blow Fly's grub. It appears certain that in this country the open warble is not generally seen until from about the 14th to the 25th of February. On January 27th, Mr. Dalton, Wigton, noticed for the first time in the season the appearance of the young warbles. He found them in two different hides, both of them from one to two-year-old cattle. The round hole in the warble was distinctly visible. It was about the size of the prick of a common darning needle outside, and below, though larger, scarcely $\frac{1}{16}$ th of an inch across.

On February 14th, Mr. McBride, county Cork, stated that the swellings were increasing in number and size on his cattle.

On February 17th, information was sent that a notice had already been given that hides on Birmingham market would be sorted for warbles, and those having more than three would be out-classed. On February 18th, Messrs. Hatton mentioned that they had received an ox hide with many warbles in it. The value of this hide was 29s.; whereas the value of the same weight of hide free from warbles would have been 35s. 5d. The amount of damage can be seen on looking at the under side of an infested hide. The swellings there are about the size of half a walnut, caused by the pressure of the maggot within. On February 20th, Miss Ormerod found an open warble in the hide of a Hereford, taken from the animal that day at Isleworth. On February 23rd, Mr. Scott, Tipperary, found warbles on cattle. On February 24th, Mr. H. Thompson, Aspatria, reported that he had found several small lumps on the backs of young cattle, but no external opening; and on the same day, some of the students of the School of Agriculture, Aspatria, found lumps on the backs of cattle at the farm; and another reported small lumps on the backs of his father's cattle, with black spots in the centre, covered with gummy matter. On February 25th, Mr. H. Thompson found a large number of warbles on the backs of cattle rising two years old. Some of the cattle had twenty swellings on the back, all showing the external opening.

Those specimens found by Mr. Dalton, and examined by Miss Ormerod, presented the first advance on the condition of a hair-like streak through the hide. These were the first perforated warbles found, the maggot within being of a clearly distinguishable size. The channel or maggot gallery was somewhat cone-shaped, with smooth, white, shiny walls. This shows that the passage could not have been formed by ulceration, which would not have given clean smooth walls to the hole. The maggots in this state of warble differed in size. The smallest she measured was about $\frac{1}{2}$ inch long, and nearly worm-like in shape, rounded at the mouth end, and bluntly-pointed at the tail; white, transparent, and marked across what may be called its back with sixteen short bands of very minute black or dark-grey prickles, placed for the most part in alternate very narrow and broader stripes. The maggots

were of different shapes, as in fig. 7, and varied according

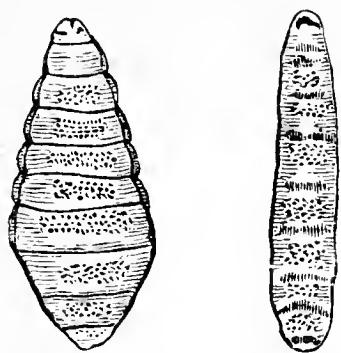


Fig. 7.—Young Maggots, much magnified.

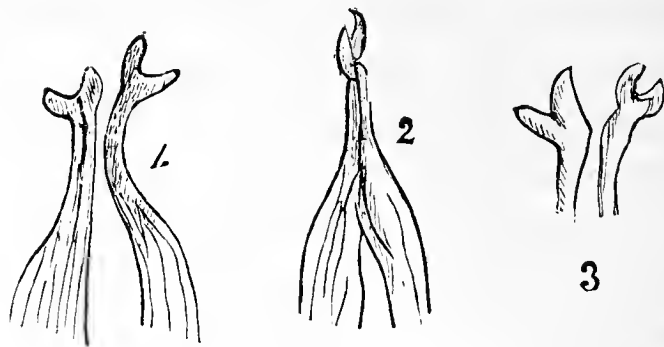


Fig. 8.—Mouth Forks of very young Maggots, much magnified.

to whether they were alive and distended with fluid, or other circumstances. In the youngest condition the maggot was furnished with a pair of strong mouth forks. These mouth forks are a most important item in its structure, and have not previously been noticed in the young maggots of this species of *Æstrus* or Warble Fly. The apparatus consists of a pair of crescent-shaped forks, placed nearly side by side, at the extremity of processes somewhat bent apart at the ends by which they are attached to the crescents, and attached by the other ends to the membranes or tissues forming the gullet or internal sac of the maggot. In fig. 8, Nos. 1 and 3, the crescent-shaped forks are shown in slightly different positions, and at No. 2 they are shown sideways, so as to present the curved ends of the processes to view. The material is chitinous or horny, and the colour yellowish-brown; and, though excessively minute, the hook forms a very serviceable cutting or dragging instrument. The possession of this apparatus by the maggot in its early stage is a great confirmation of the belief that the creature gets down to the sub-cutaneous tissues of the hide by cutting its way forward. We appear here to have both cause and effect, for we find, as a regular thing, that there is a minute track down to the embryo warble beneath the hide, which track has the appearance of having been cut or gnawed, and in the exceedingly young and still worm-shaped maggot found on January 27th, there was the apparatus for cutting or gnawing. The Warble Maggot in the early stage is oval, legless, and headless, and is white, transparent, and smooth. "Up to the time of its first moult," according to Dr. Friædrick Brauer, "the maggots lie quite free in the sub-cutaneous tissues and skin muscles, and are not contained in any capsular formation; but in its second stage it is thickly beset with groups of prickles, which soon

irritate the surrounding parts, the tissue of the hide is disturbed and thickens, new formations of tissue take place, and the maggot becomes enclosed in a sac; and, from the continued irritation, ulceration is set up, and the weakest part of the skin is burst through into an orifice."

After its first moult, however, it gains a skin beset with groups or small bands of very minute prickles, and by the presence of this rough surface, irritation and ulceration are set in. After the opening of the warble, the maggot lies with its tail end (which is furnished with two dark horny spiracles or breathing pores) nearest the opening, so as to enable it to draw in supplies of air. The mouth end lies towards the bottom of the cell. As the maggot grows older it gets darker in colour, until it is dark grey or almost black, with the patches of minute prickles showing fairly plainly, the sac or cavity enlarges, and when the maggot has come to its full growth, in the May or early summer after the egg was laid, it presses itself out of the opening of the warble, and, falling to the ground, finds some suitable place, as under a stone or clod of earth, or in the turf, to turn to chrysalis in, and there it changes into the perfect fly. Occasionally the change to the chrysalis state takes place in the warble, and in that case very likely there will have been something to prevent its escape—either inability to get out, or perhaps a blow outside of hide.

The sore, caused by the suction and movement of the small tubercles and patches of prickles that surround the opening which serves as a mouth, gradually advances before the mouth end of the maggot, till, when it is full sized, in the following year after it is hatched, it may be found lying, somewhat bent, in a cell more than an inch long; which, when the hide is taken off, may be seen pressed out beneath by the contained grub, like the end of a glove with the finger in it. At this time the lowest part of the warble cell is an ulcerated flowing sore, but the upper part may be found nearly skinned

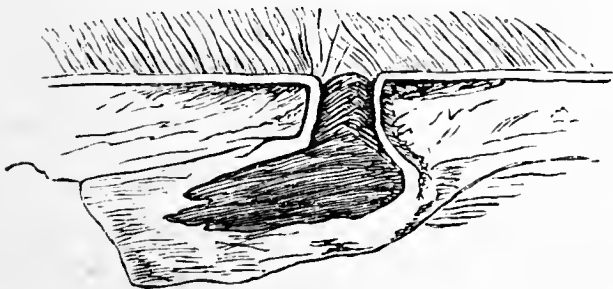


Fig. 9.—Warble Cell, slightly larger than life.

over round the perforation as in fig. 9. On pressing the warble after the maggot has come to its full size, the maggot is squeezed out, and on placing it on the hand, I noticed it kept up a regular

contraction and expansion of the mouth end; and it also swayed from side to side, and as this moved the prickles there is no wonder at the irritation it keeps up in the sac. On the under surface of the hide, although the surface may not often be broken, yet the sub-cutaneous tissues are left as a film of no strength, which injures the surface of the leather. The warble with the maggot in it, although most prevalent in April and May, is found occasionally much later in the year. The maggot begins to escape from the warbles in April, fast leave the cattle in May, the hides are almost free from them in July, and the date of the last observation of the maggot in warble was August 2nd. In getting out of the warble, it compresses itself, and shoves itself forward ring by ring, the prickles preventing it from slipping back, until it is quite free, when it tumbles to the ground. After the maggot escapes, a quantity of matter can be squeezed out of the warble, and in some cases it is very thick and muco-purulent.

Mr. H. Thompson examined the backs of several carcasses when the skin had been removed, but could not find any marks to show where warbles had been, but some of the fleshers told him that at times they (the maggots) penetrate the flesh, and spoil the sirloin. Mr. J. Dalton states that in two or three weeks after the escape of the maggot the hole quite closes up, and the only trace remaining is the cicatrix where the wound had been. In some pieces of leather you may notice both holes and marks, the latter are the healed wounds of the previous year—the scar always remains. Sometimes the young maggot dies in the hide, whether from unseasonable development or some other cause is not known.

Miss Ormerod found the young maggot different from the adult both in form and texture. The smallest she examined was about $\frac{1}{4}$ inch long by about a third of that in width, not oval, but straightish, or somewhat worm-like in shape; when older they become rather enlarged at the mouth end, so as to be of a long pear shape, and (excepting dark cross bands of prickles extending about one-third round them) were white, and partially transparent. While these small maggots were apparently alive, they were hard, and externally, over almost all their surface, of glassy smoothness. On placing the very young maggots in water, they swell so much

as to become exceedingly rigid, and so transparent that much of the internal structure could be seen plainly. The rigid glassiness of the young maggot favours the presumption that it forces itself up the channel from the sub-cutaneous tissues to the outside of the hide, small end foremost, with its first spring growth, and gradually enlarging the hole by the pressure of its own hard, inflated, and rapidly changing condition, forms the warble hole. The upper part of the passage is not torn or ulcerated as below. Disorganised tissue and ulcerated matter are sometimes dragged into the channel by the maggot, and in the opening of the warble we sometimes find a slight coating of gummy matter on the tip of the maggot; but the great mischief from disorganisation, swelling, and inflammation is done beneath the hide.

The conditions of the very young maggot named above, combined with the peculiar shape and pointed ends, adapts them perfectly in the first stage for travelling, in the second for pushing themselves up small end foremost, armed with minute hard spiracles, through the opening warble. The above changes in condition are rapidly gone through, and when the maggot has gained about a quarter or a third of its growth, the spiracles are developed into an angularly kidney-shaped form, and the maggot assumes the compressed oval shape in which it is best known. It is still white, but opaque, with the segments well marked. It has no occasion now to bore its way, and ceases to be provided with a form fitted for perforation. Miss Ormerod found by microscopic investigation that the spiracles have two, and she thinks three, different successive forms before developing into the last state; and they also differ from each other in the amount of spiracle exposed at tip of grub. The breathing apparatus consists of a trachea or breathing tube from each of the spiracles, and from each trachea a series of lesser and lesser tubes carries the air through the maggot. The two principal tracheæ are connected together near the spiracles by another short tube, which forms a channel of communication, and thus ensures air being supplied to the maggot if one spiracle should be choked. In a short time the maggot is to be found advanced to its oval form, and the passage through the hide to be then covered with a coating of membrane.

On the 3rd of March, Messrs. Hatton sent Miss Ormerod a piece of heifer hide less than 6 inches square, containing twelve or more warbles, which showed on flesh side of hide as well-defined lumps ranging from $\frac{3}{8}$ to $\frac{5}{8}$ of an inch across, and $\frac{3}{8}$ of an inch in height of swelling. All had openings in upper side of hide, and internally were coated with a distinct formation of some sort of lining membrane, like thickened yellowish skin, continuous with the coat of cell below. Within the cells, in same hide, the maggots lay, still whitish, hardly a quarter of full size, but advanced to the compressed oval form, with broad and narrow bands of prickles, and with kidney-shaped spiracles.

The spiracles are placed at the extremity of the body instead of on the sides as usual, in order, as it would seem, to avoid the necessity of having a large orifice in the swelling, which would interfere with the comfort of its temporary occupant. The orifice is about $\frac{1}{8}$ inch in diameter at the top, gradually increasing until it has passed through the firm parts, when it bends in its course, and forms an irregular bag about 1 inch long in the sub-cutaneous tissues. In this bag or sac the maggot lies slantwise, with its tail in the orifice and its mouth-end downwards.

The duration of special habits of life in the maggot may be divided into three periods:—1st, The youngest state, when its chief work appears to be to make its way through the hide downward; 2nd, When it starts into the active state which precedes its first obvious appearance in the opening warble, and in which its most important work is forcing its way up again, tail foremost; 3rd, In which, having formed the opening, it lies within, feeding, mouth end downwards, in the filthy discharge its own presence causes, until it is ready to leave the hide. In forming the perforation, the tip of the tail of the maggot, which is ended in this stage of its life by two somewhat club-shaped spiracles, which when highly magnified appear like short bent cylinders, as in figure 10. These are composed of horny or chitinous materials, and each of them is placed at the extremity of a large trachea or breathing tube, which pair of tracheæ are



Fig. 10.—Spiracle Tube (one of the pair), much magnified.

joined together near the spiracles by a transverse tube. The maggot is thus furnished with a compact hard-tipped apparatus, very suitable, with due pressure from behind, to force open and gradually enlarge the fine passage leading down, in the early stage of attack, from the outside of hide to the embryo swelling beneath. The power of pressure, says Miss Ormerod, possessed by the maggots at this period of their life is enormous, from their power of inflating themselves with fluid until they are so hard it is scarcely possible to compress them with the fingers, and likewise from their having apparently no power of discharging any of their contents. Thus they form living and growing plugs, quite capable of pressing back the tissues from around them, or from before the small hard tip; but not subject, so long as they continue inflated, to being themselves compressed. She had opportunities of watching this process of inflation both in worm-shaped maggots and when they were slightly more advanced in growth to a club or lengthened pear-shape. On placing them in fluid suitable for absorption (as in glycerine and water), they became hard and shiny, with little trace of the segments which are so clearly marked when the maggots are fully developed; in fact, they were almost of a glassy smoothness, save for the short bands of minute prickles placed along a portion of the back. This hard, almost glassy-smooth outside, with the pointed ends at first, and afterwards with the end that needs to go foremost being, or nearly so, pointed, makes it peculiarly suitable for forcing a passage up the hide. When she put the maggots in water, she found the young ones swelled until the air-vessels showed beautifully along the side of the smallest. They have also the power of exuding quantities of minute globules of air on the grey bands of prickly surface. After a time they get quite brilliant with the air-globules; but, except at the spiracles, air does not appear elsewhere. On clearing the maggots, the air-globules appeared again after a short time.

The size and shape of the perforation through the hide altered progressively with the growth of the maggot. At first the passage was very little larger at the lower than at the upper opening, and though the walls of the perforation had now become smooth and shiny, she could not distinguish the

presence of any distinct lining membrane. With the enlargement of the passage, its shape became more cone-like, corresponding with the altered form of the maggot; and on March 5th she found for the first time a distinct skin-like membrane, covering the walls of the perforation or passage, and continuous with the lining of the maggot cell below. The amount of development of the warbles at a given date varied very much; warbles just beginning to form might be found together with those nearly three-quarters of an inch across, as measured on the fleshy side of fresh hide on the 4th of March; but, when once started in growth, the progress was very rapid.

The great change, both in the appearance and the internal structure of the maggot, took place when it was grown to about one-third of its full size, when it assumed its well-known shape. Previously to this, its chief characteristics, externally, were the absence of anything that could obstruct its power of pressing onwards; and internally it was little more than a bag of fluid, with a large proportion of the space occupied by breathing tubes—a very important consideration relatively to available methods of destroying the creature. At the period, however, of its moult to its final stage, a change takes place respectively in the nature, or in the amount of development of nearly the whole of both the internal and external structure of the maggot. The hard tips are now no longer necessary for forcing a passage, and they are exchanged for a broad form of spiracle, and the internal organs become suited to provide material for the development of the fly, which will presently form in the dry husk of the maggot which serves as the chrysalis case. One of the first and most remarkable of these changes is the complete alteration in the form of the spiracles. Up to this stage the general form continued to be that of a pair of short, horny, somewhat bent, cylindrical, or partially cylindrical tubes, covered at the end (fig. 10) with round or oval discs, which appear to have a definite narrow border, and across the centre of the disc to be of a sieve-like or spotted appearance. These discs may amount to as many as twenty-six on each spiracle, and appeared to her to be placed each at the extremity of short cylinders. The structure is most elaborate and peculiar.

Whether the spotted or sieve-like appearance of the discs on the spiracles is caused by microscopic hairs placed to preserve the entrance free, or by other structures, she could not ascertain on account of the excessive minuteness of the organs; but the use of such an apparatus to guard the entrance of the breathing tubes, when acting in a passage which is formed in the living hide, is obvious.

Up to the time when the moult takes place to the final form, these spiracles are buried up to their disc-covered tips in the tail end of the maggot; but then they are cast off entirely with the moulted skin, and in the newly-exposed skin beneath, we find the first appearance of spiracles of the well-known kidney shape, but with the surface more radiated, and of a paler chestnut colour than in their later condition. In spring, Miss Ormerod had frequent opportunities of observing and securing both the moulted skin containing the early form of spiracle, and the proprietor maggot, bearing the new kidney-shaped pair. The newly-formed spiracle is furnished on the upper surface, with numerous cylindrical pores or openings, which are the termination of cylindrical passages which are connected lower down, and which appear to be ramifications of a small number

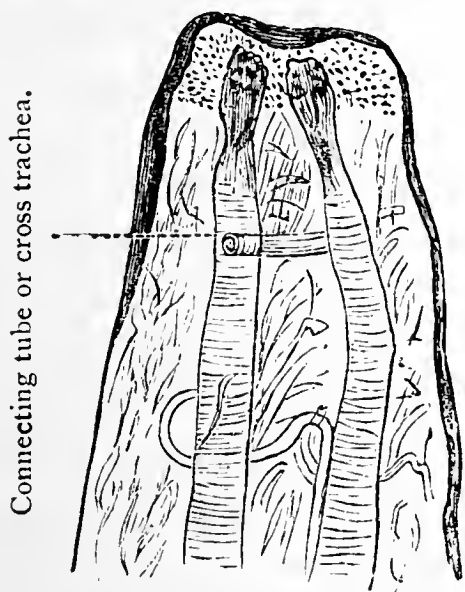


Fig. 11.—Spiracles and tracheæ of young maggot, much magnified.

of upright passages opening from the great trachea below, and passing upward through the spiracle, thus giving communication to the outer air by means of the cylindrical branchlets with their open extremities.

The skin of the maggot becomes furnished within with a powerful coat of muscles, extending over it like basket-work. A maggot at this stage, besides the power of contraction and expansion, has a power of dragging itself along at a rate of three times its own length in two minutes, and has a very definite mode of progression. The mouth end is somewhat raised, and the creature appears to move with as settled a purpose in any given direction as other grubs or caterpillars. Externally, in this stage the skin of the maggot is furnished with a much larger amount of prickles, arranged in more numerous bands,

than are noticeable in the previous stages. The prickles are now strong enough to cause an unpleasant sensation when the maggot crosses the hand, and to play an important part in its locomotive powers in its cell, and in the effect of the tissues caused thereby. The visceral contents are now thick, and obviously formed of the filthy matter in the cell. It is also now furnished with a small curved caudal aperture, placed nearly between the spiracles, from which some slight amount of discharge of contents can take place. As the maggot grows the lining of the cell (fig. 9) increases in thickness, until it becomes well defined as a tough wall round the perforation, continuous with the upper part of the cell. When the creature has gained the condition named above, it undergoes no further great change until it turns to the chrysalis state. The spiracles become less radiated and darker, the



Fig. 12.—Maggot of Ox Warble Fly, drawn from life, life size.



Fig. 13.—Chrysalis of Ox Warble Fly, side view, and showing contained fly.

maggot also becomes darker, but the main points of its life now are to form, at the expense of the animal in which it lives, the material from which the fly will presently be developed, to start (unless means have been taken to prevent it) the next season's attack on the herd.

On April 21st, I pressed two maggots out of cows, and two days afterwards seven more, with very little force, five of them from cows, and the other two from yearling heifers. They were from $\frac{3}{4}$ inch to 1 inch long, from $\frac{2}{5}$ inch to a little more than $\frac{1}{2}$ inch in width, and were slightly less in depth. They were of an oval shape, and blunter at the mouth end than the other, and varied in colour from pale yellow to black. They kept up a regular contraction and expansion as they lay on the table, and moved their mouth end from side to side in all directions. The breathing spiracles at the hole of the warble were noticeable as two black spots. Their bodies had from nine to ten rings going right round them. The skin

was of a tough, leathery, elastic character, and had a number of patches of minute prickles on them. The under surface of the body was slightly flattened, and the skin had a wrinkled appearance. I put these maggots in some soil in a pot, covering them to the depth of one inch, stretching some muslin over the top. The next day they had wriggled their way to the surface of the soil. Some of them died, but by keeping the soil moist the remainder kept alive. In a few days their skins became quite hard and stiff, and turned quite black in colour. All of them afterwards died and moulded except one, which I opened on June 19th, and found it partly filled with a clear liquid. In this liquid was a whitish semi-solid substance in the shape of an insect. The top of the chrysalis came off like a lid. Some of the warbles were scarcely perceptible to the touch on April 23rd, and the orifice was very small—about the size of the prick of a common darning needle; but others were as large as half a walnut, with an orifice about $\frac{1}{5}$ inch in diameter. Some of the warble holes were covered with dried gummy matter which had exuded from the maggots, while others were quite free from it. A month afterwards, in looking over the heifers from which I ejected the maggots, I found that nearly all the holes were healed up; in others, where I had applied mercurial ointment, the dried-up maggot was protruding from the orifice about half an inch, and were easily pulled out of the hole. They were black and shrivelled up. There were a quantity of maggots in warbles in the beginning of June. On June 10th, the maggots were nearly matured and ready to fall out. On June 25th, I pressed some maggots out of warbles on yearling bulls, and covered them with soil about one inch deep in a pot, covering the whole with gauze. The following day, two of them had found their way to the top, and were lying bare. They afterwards died. I believe the reason why they did not live, and turn into the fly state, was that by pressing them out of the warbles I either did them some injury, or that they were not ready for the chrysalis state.

The chrysalis is dark brown or black in colour, and much resembles the maggot in appearance, but is flatter on one side. Its external coat is the hardened skin of the maggot,

which has contracted so as to form a case for the developing fly within. The chrysalis state generally lasts from 20 to 30 days; but this period may be lengthened by cold weather, especially severe night chills.

Where the plan has been adopted of killing the maggots in the warble in April and May by various applications, there is found to be absence, or very slight presence, of Warble Fly attack; and where the maggots have not been destroyed, the cattle have been found to be attacked as a regular thing. If as soon as the warble is perceptible to the touch, and the opening has formed, it is dressed with a little mercurial ointment, the maggot will be killed at the beginning of the sore, instead of after it has been established several months. The maggot may be pricked, stabbed, or poisoned in a variety of ways, or it may be killed after coming to maturity by being pressed out. Tar applied to the warble has been found to kill the maggot; and many other applications which would poison or choke it would do equally well. Although this treatment in April and May is so far good that it lessens coming attack, it is after the cattle have been undergoing the drag on their system by the dozens or scores of maggots, that the damage to the hide has been done. What is really wanted is that egg-laying be prevented, or that the maggot be destroyed in the warble when it first bursts. In the United States it has been found that a little mercurial ointment, rubbed on the swellings in autumn, acts very well in killing the young maggot; but the simpler and equally effectual way is to rub the sides, and especially the backs, of the cattle with kerosine oil. Prof. Riley, State Entomologist, U.S.A., said it was the custom to give one rubbing along the back and loins with kerosine oil, or with mercurial ointment, in autumn, when the grub was accessible in the hide, and this was enough to destroy it. Two applications were sometimes made. Miss Ormerod thought that the application known as kerosine emulsion, in which it is beat and worked with water and a small quantity of soap into a kind of cream or lather, would be much more effective than the mere oil.

Piercing the maggot is not perfectly certain to kill it, as the operation is not always thoroughly performed. Stabbing also appears painful to the cattle, and it is difficult to get at

those which have only a small orifice, or none at all ; whereas mercurial ointment kills them all, and is quite painless. Mr. Stratton tried acetic acid on some warbles, tar on others, and mercurial ointment on others, and they were all effective in killing the maggot, except in one or two cases where he thought the tar did not get to the maggot by reason of the hair. Mr. Jos. Addison states that the yellow mercurial ointment destroys the maggot in the warble. It must be rubbed in slightly. Mr. E. E. McBride states that a piece of mercurial ointment the size of a pea carries death within twenty-four hours. Mr. D. Turvill testifies that thrusting a needle into the warble maggot kills it without seeming to cause the least pain to the animal ; but the cattle would only stand when tied up. McDougall's sheep-dip has been successfully applied by rubbing some in the holes, and no doubt the smear would be useful. Mr. Stratton states that in two days after applying the ointment, the grub appeared to be quite decomposed. The mercurial ointment must not be applied in broadscale fashion, but only a piece about the size of a pea to each warble. In June, 1885, in some beasts belonging to Mr. Trethewy, Cornwall, which beasts had a large quantity of maggots in their hides, and were treated twice with mercurial ointment, one was paralysed and had to be slaughtered, another was badly salivated, and several others were very ill. It is supposed the ointment was applied broadscale. Tar will kill young or small maggots well ; when older, the tar must be thick and adhesive, as the maggot is less sensitive. Hog's lard and carbolic acid have been found serviceable. The point wanted is to choke the maggots by filling up the breathing pores at the black tip of the tail, and also to apply something which will ooze down to the bottom of the hole, and thus poison the maggot, which has no means of avoiding drawing it in along with the filthy matter on which it feeds. The application of strong brine has been reported as not answering to kill the maggot in the warble. Mr. Duckham, Ross, applied a mixture to warbles on calves' backs, composed of one part carbolic acid to twenty of hog's lard, with excellent effect. The grease stops the breathing passages, and the carbolic acid poisons it. N. E. White's mange ointment is effectual in killing the maggot.

Miss Ormerod thought a rub with the end of a dip candle would be enough.

I put a small piece of mercurial ointment on some open warbles on the 23rd of April, pricking some of the maggots with a pin previous to putting on the ointment. A clear gum-like liquid exuded from the maggot after pricking. The next day, all the maggots treated were dead. After pressing the maggots out of the warble, a quantity of matter came out. In pressing out the maggots, the animal seemed to feel pain. The cattle were very prone to lick off the ointment, both from themselves and others, so that I think it unsafe to apply much at one time. I applied tar to the maggots on several cattle, putting a small portion on each maggot. On examining them two days afterwards, I found the maggots were dead.

In one specimen of leather there were about twenty-four holes caused by the warble maggot on a surface of 12 inches by 3 inches. The loss in value on warbled hides is often 10s. or 15s. apiece; and Mr. Stratton is of opinion that from injury to health, milk, and other causes, there was a loss of £1 per head per annum on the cattle in this country through the injuries inflicted by the Warble Fly. He estimates the total damage caused by this insect at £8,000,000 sterling. Mr. W. H. Liddell estimates the damage as upwards of £2,000,000 sterling a year in Great Britain and Ireland, but the exact amount is not known. The loss is certainly very heavy. Miss Ormerod examined a hide on February 20th in a horrid state, with some of the mischief certainly owing to warbles. She found in one place a patch full two inches in diameter, and along near the spine the sub-cutaneous part of the hide was full of what she described as slight enlargements or "puffs" with blood or matter, or what seemed like lumps, almost like stringy greenish matter. The upper part of the carcase opposite to this bad state of things was discoloured.

The following are the particulars of seven weeks' supply of six classes of hides, being the total of each class of sound and warbled, sold at two markets in Birmingham, commencing May 3rd, up to and including June 14th, 1884, and showing the actual loss on each class of warbled hides:—

From Miss Ormerod's "Observations on Warble Fly."

SIX CLASSES OF HIDES.		HIDES.		Sold at	Per Hide less than the Sound.	Loss on each Class.
Weight from		No. of Sound.	No. of Warbled.			
95 lbs. and upwards	...	286	67	$\frac{3}{4}$ d. per lb., or 6/3 per hide	...	£20 18 0
85 „ to 94 lbs.	...	446	222	$\frac{7}{8}$ d. „ „	6/7 „	73 1 6
75 „ to 84 „	...	754	373	Id. „ „	6/8 „	124 6 8
65 „ to 74 „	...	881	579	Id. „ „	5/10 „	168 17 6
56 „ to 64 „	...	629	441	Id. „ „	5/- „	110 5 0
55 „ and under	...	283	224	Id. „ „	4/3 „	47 12 0
Totals	...	<u>3,279</u>	<u>1,906</u>	Total	...	<u>£545 0 8</u>

It will be observed that of the total number of hides (viz., 5,185), over one-third were warbled; and looking merely at one line of the figures, it shows that out of 1,460 hides, ranging from 65 to 74 lbs. weight, 579 were lessened in value at the rate of 1d. per lb., or 5s. 10d. per hide, giving a total loss on these of £168 17s. 6d. The above table of particulars does not include the classes known as "heavy" and "light" cows' and bulls' hides, which also were warbled, but of which the numbers were not taken.

Mr. C. Haines, Newport, says he seldom saw much of the warbles in the pelts, excepting during March, April, and May; so it would seem in the early stage of its propagation it would not materially affect the hide. He usually commences to notice them as April comes in. For about a week he judges 50 per cent. to be damaged; in the next two weeks, 20 per cent.; and for one month additional, say 10 per cent. Allowing thus liberally should about cover the year's damage. That done to hides is only a small part of the damage this fly causes. What by abortion, watching, galloping, and standing in water instead of feeding, less quantity and worse quality of milk, and interference in the progress of fat cattle, the damage must amount to a very considerable sum.

The damage is generally greatest on those hides from the hottest climates. The hides and skins from Mogador, and other northern parts of Africa, suffer most, an average perhaps of about one-quarter of them being damaged to the extent of 60 per cent. or 70 per cent. Those from Kurrachee suffer damage to almost the same extent; while those from Calcutta, Madras, and Bombay are depreciated perhaps to the extent of 50 per cent. on 10 per cent. of the skins. From Cape Colony the damage is comparatively slight, and still less in those hides and skins from Australia and South America.

Feeding cattle cannot grow in flesh without quiet and rest, and cows very soon give less milk, and worse quality, if driven fast or made excited. These tormenting flies, and the presence of the prickly-coated Warble Maggot, must keep up a perpetual uneasiness, and retard the growth of our feeding cattle to our loss, it may be, of £2 per head. In dairy cows the loss will be greater. The daily loss of milk may make a difference of 1 cwt. or $\frac{3}{4}$ cwt. of cheese per cow per annum ; so that their loss may be put in some instances at £3 per head, and for others less.

Mr. H. Thompson says :—"I would say there are from fifteen to twenty warbles on one animal where the land is well sheltered by trees, but where the land is open, the warbles are more numerous." The number of warbles on one animal may be 6, 10, 20, or even more than 100, one inch long, and feeding on sores which they keep up from January or February until they are full grown. The proportion of warbled to sound hides increased very rapidly after February 4th ; and on April 18th, out of the total number of hides of eight classes purchased on that day, amounting to 435 hides, 163 were warbled. In some cases the great maggot-infested swellings on the flesh side of the hide were so close together as to form confluent masses ; and in one piece sent to Miss Ormerod by Messrs. Hatton, measuring somewhat under 28 inches by 8 inches, there were seventy-two warble swellings. Some of the hides thus infested were from animals which had died of illness considered to have been aggravated or caused by the horrible state of their backs, from the action of these maggots. According to P. H. Gosse, in the "Canadian Naturalist," warbles are commonly called "wormuls," originally "worm-holes." He states they will not go into the pupa state after being ejected from the warbles. The number of maggots I found on one beast varied from one to twenty. Mr. W. H. Liddell published a letter in December, 1880, in which he says :—"There are at present, I may safely say, three-fourths of all our cattle being tortured by this inveterate insect, which by a little trouble, and at a nominal expense, could be extirpated ; and thus we should save an immense amount of capital, and wipe out a disgrace to all who neglect their cattle."

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Warbles
Prevention

